Risk Management on MRO

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&

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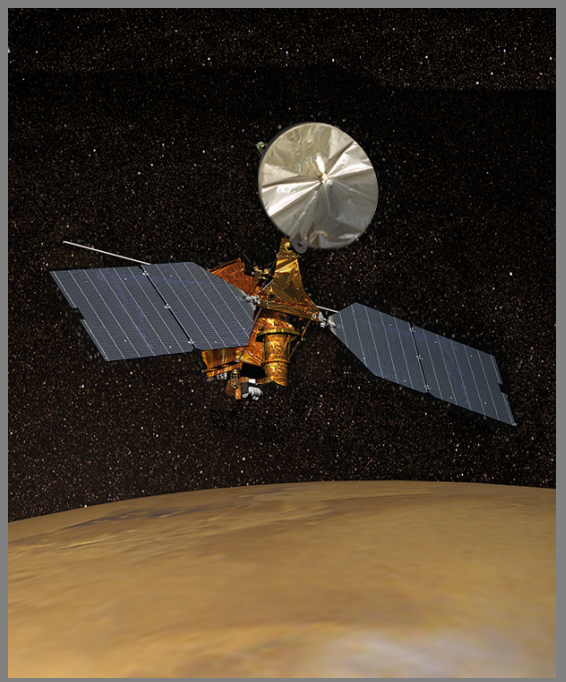
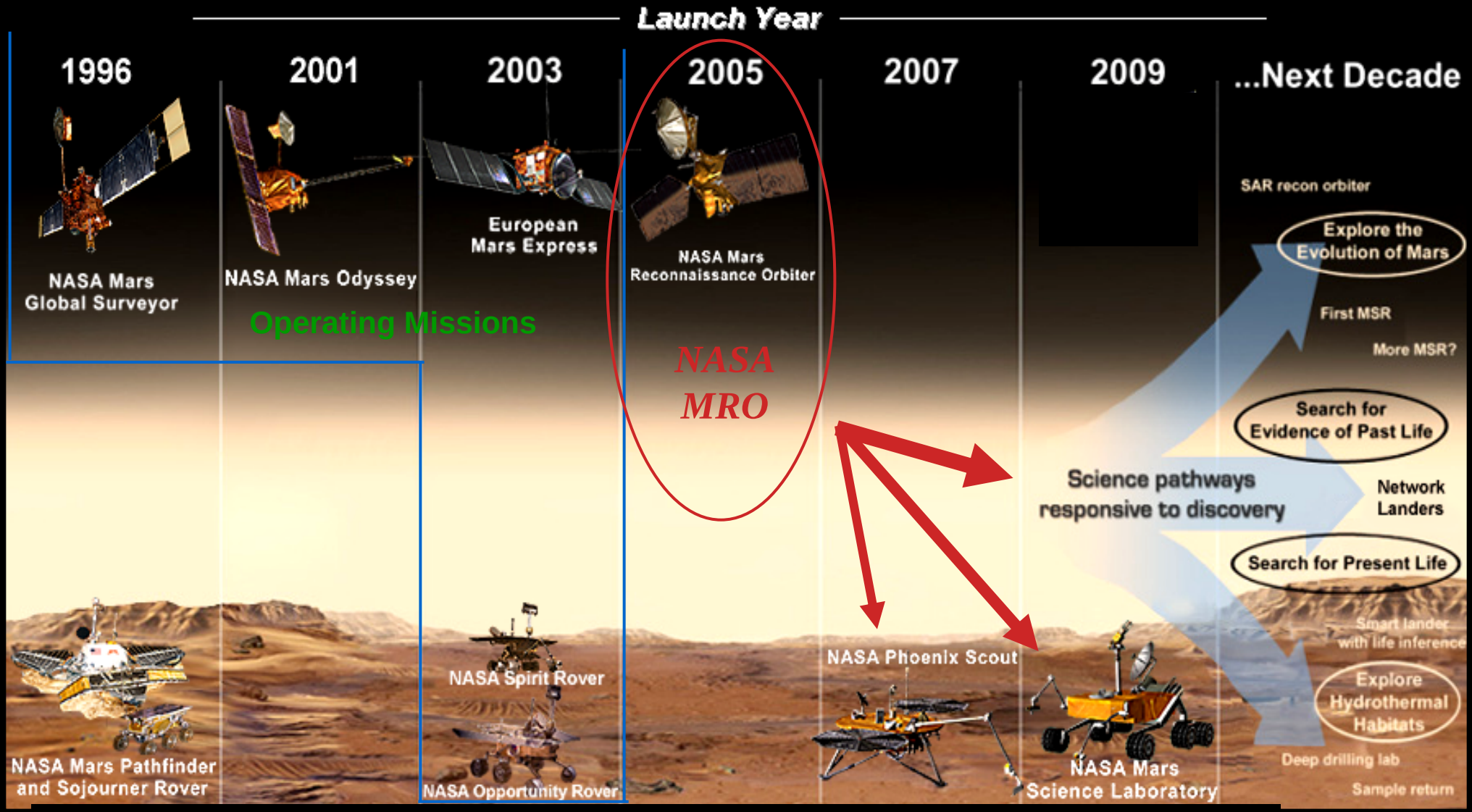


Outline

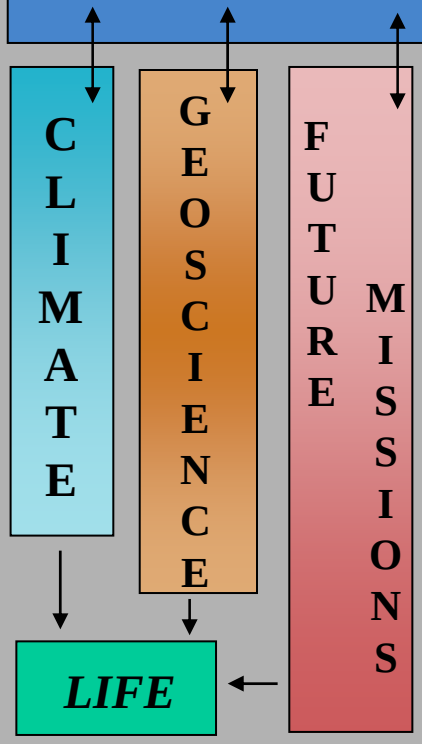
- MRO mission overview
- Key Challenges
- MRO RM Case Study
- Lessons Learned

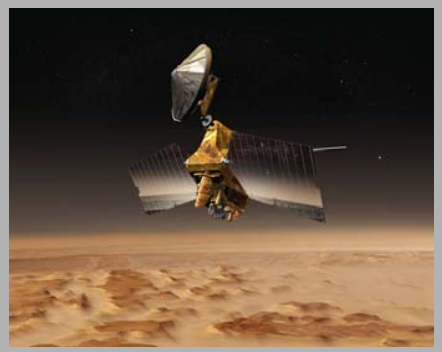
Robotic Mars Exploration



MRO Objectives

"Follow the Water" Theme





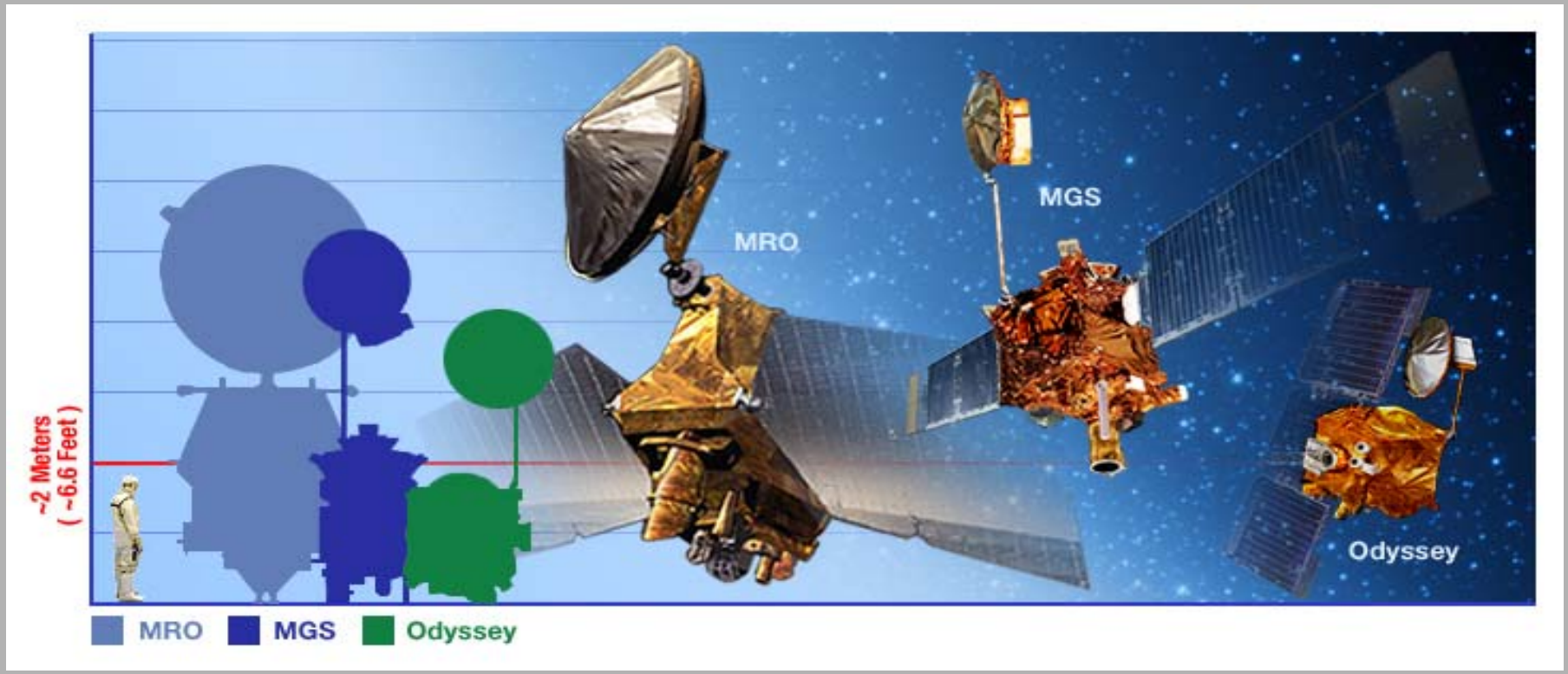
MRO is a:

- ***Weather Satellite***
  - Monitor the present climate, seasonally & year-to-year
- ***Geological Explorer***
  - Identify water-related landforms & aqueous deposits
- ***Site Finder***
  - Observe hundreds of sites at very high-resolution to find the best places for future landed exploration
- ***Communications Satellite***
  - Provide relay for Phoenix (2008) & MSL (2010)
- ***Technology Pathfinder***
  - Demonstrate optical navigation and use of new telecom frequencies (Ka-band) for future missions

MRO Flight System Description

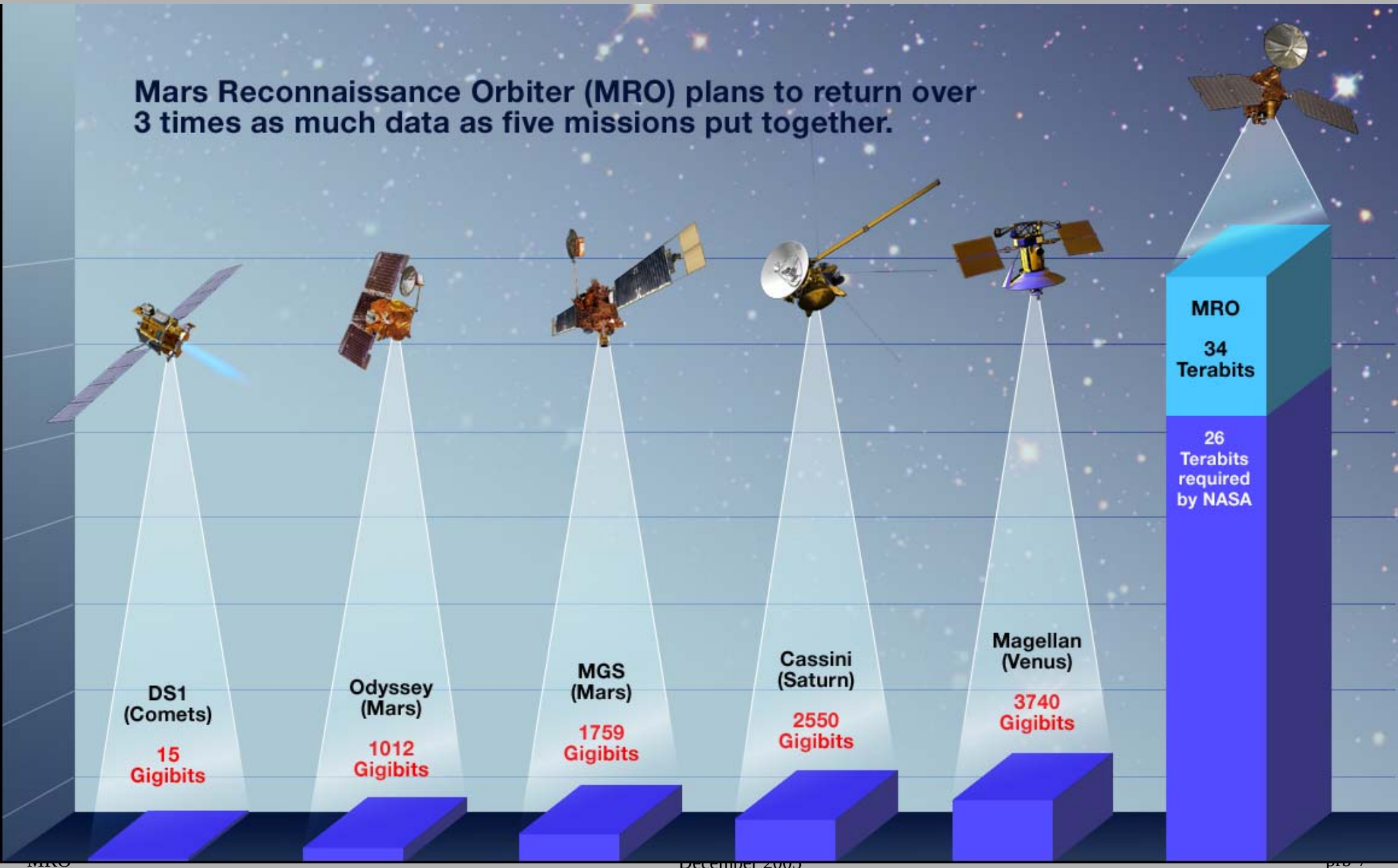
Launch mass: 2180 kg
Size: 14 m solar array tip to tip
and 7 m high
Array power: 6 kW (BOL/1 AU)
Maximum data rate: 5.6Mb/s
Other engineering attributes:
3 m HGA/100W TWTA
Monoprop propulsion: 1710 m/s
100 N-m-s wheels
Rolls to +/-30 deg.
Payload
6 science instruments
3 engineering payloads
2 non inst. investigations

Recent Mars Missions Comparison



Item	MRO	MGS	Odyssey
Launch Year	2005	1996	2001
S/C Wet Mass (kg)	2180	1055	733
Science Orbit (km)	255X320	400	400
Ground Sampling (m)	0.3	1.5	18
Data volume (Gb/sol)	20-90 *	0.7	1

Data Return Comparison



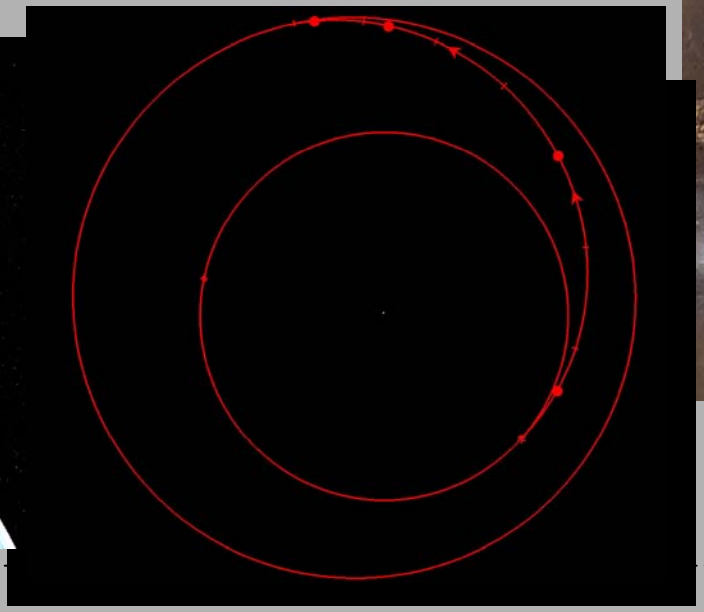
MRO Mission Overview

NASA RMC VII

Launch
Aug 2005

Atlas V-401

Interplanetary Cruise
Aug 2005 - Mar 2006



Approach and Orbit Insertion
Mar 2006

Capture Orbit ---
Period: 35 hrs
Asc Node: 8:30 pm LMST

Aerobraking
Mar-Nov 2006

Primary Science/Relay
Dec 2006 - Dec 2010

Science Data Acquisition/Return

Primary Science/Relay Orbit ---
Period: 112 min
Hp: 255 km Ha: 320 km, Frozen
Ascending Node: 3:00 pm LMST (Sun-Sync)

Project Status

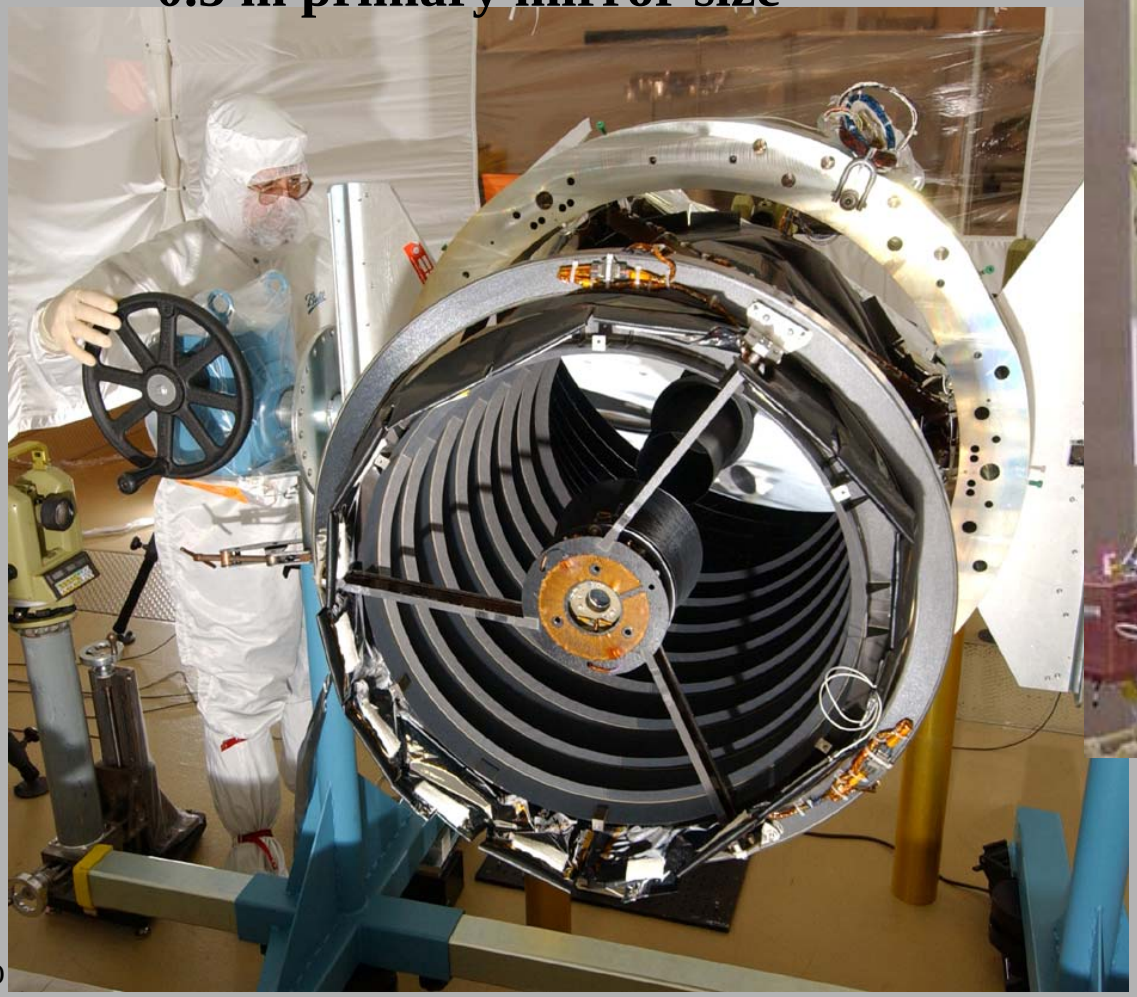
- Launched on the August 12, 2005 onboard an Atlas V 401.
- Conducted two TCM and numerous engineering and Instrument calibrations
- Performance to-date has been nearly flawless

Key Challenges - 1

- **MRO was one of the 1st JPL project to be implemented following the Mars '98 failures**
- **Following the '98 failures, JPL overhauled the way in which projects are implemented, reviewed and monitored by mangement**
  - Led to the JPL Design Principles and JPL Flight Project Practices
  - Formal reviews for: Risk, TLYF, Peer
  - Systems Engineering much more engaged in project audits
  - Audits for all the above
- **MRO was the 1st major project to put these new requirements into our contracts for the spacecraft and instruments**

Key Challenges - 2

- **HiRISE - Resolves 1m objects**
  - **63 Kg - 14 CCDs**
  - **16 different thermal zones**
  - **0.5 m primary mirror size**



Key Risks:

1. **CCD Alignment**
2. **Parts Reliability**
3. **Contamination**

Key Challenges - 3

Key Risks:

1. Not enough energy
2. Material fatigue
3. Mechanism failure

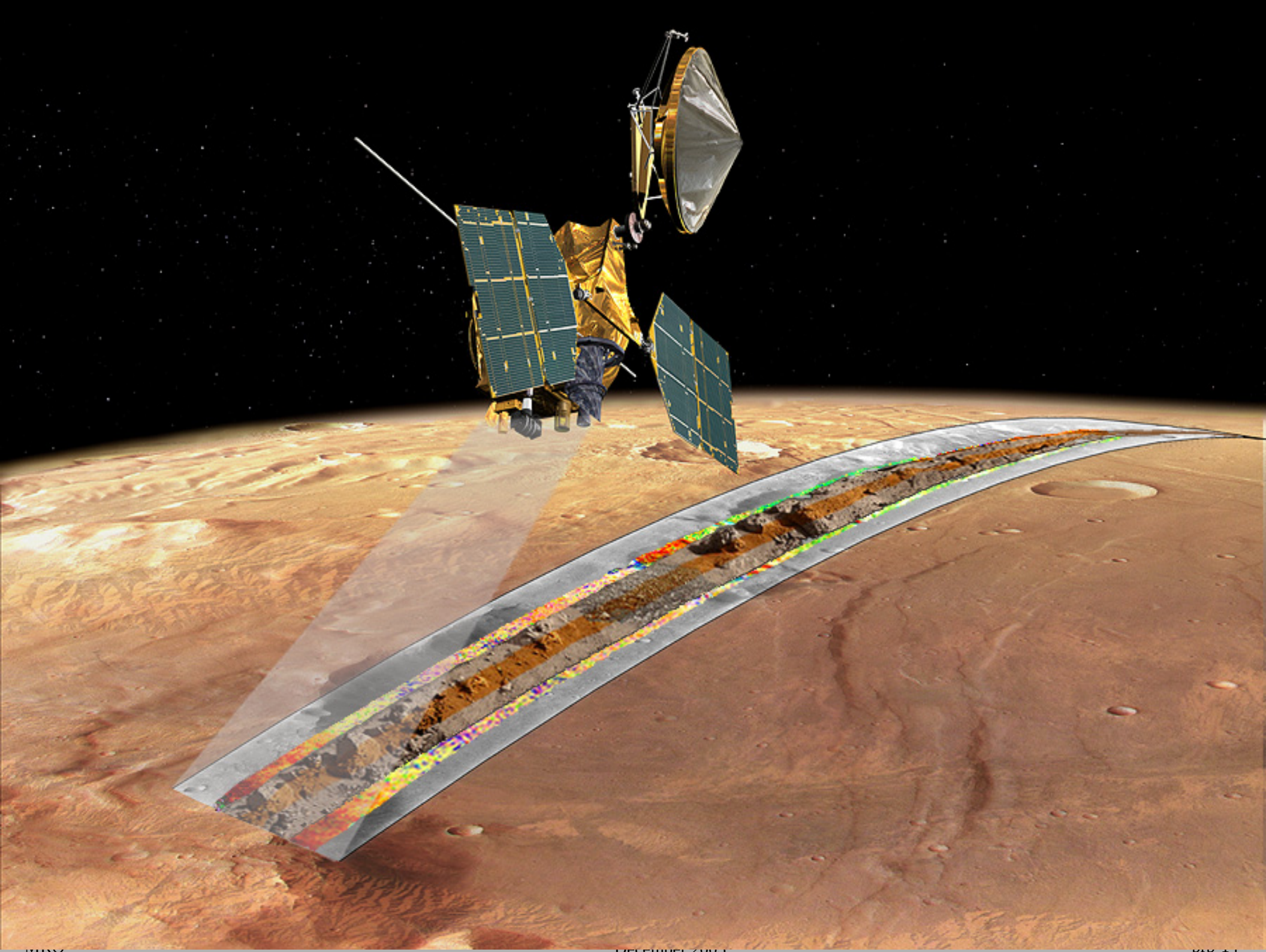
- **SHARAD -Ground Penetrating Radar -**
  - **Looking for ice & water**
  - **Deployable antenna based upon the MARSIS design**
  - **Continual development problems with this “heritage” development**
  - **ITAR limitations**

Key Challenges - 4

- CRISM - Spectrometer for analyzing surface composition
  - 34 Kg
  - Hyperspectrol imager
  - Global survey mode followed by higher resolution of select locations

Key Risks:

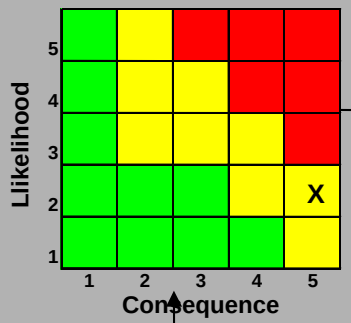
1. **Cryo Cooler Load/Lifetime**
2. **Hybrid Power Supply Reliability**
3. **Contamination**



Risk Mangement = Effective Communications

Project team members, including management, discussing threats and mitigation strategies on a regular basis and taking ACTION

MRO Risk Management Process



Box A ← No ← **MAM & SM Monthly Review** → Yes → **MAM-PM Monthly review** → Yes

Box A ← No ← **MAM-PM Monthly review**

Risk/Problem Database
File Maker Pro
Maintained by CM Eng
Distributed Weekly

Risk status is changed to "retired" and so indicated in data base

Risks Presented at MMRs

Identify Risks anywhere, anyone

Red–requires mitigation,
Yellow–may require mitigation
Green–no mitigation required

PM decides to implement Mit plans

No → **BOX A** **Risk is re-evaluated**

Yes → **•Fund Soft Lien**
•Apply reserves, kg, W, days
•Change Req via ECR

Component Mgrs
Mission Assurance
Finance
Risk

Variety of Risk Definitions

PROBLEM REPORTS (PFRs)

Failure Effect Rating (Ignoring Redundancy)		Failure Cause/Corrective Action Rating	
Negligible	1	1	Known cause/Certainty in corrective action. No residual risk.
Significant	2	2	Unknown cause/Certainty in corrective action. No residual risk.
Major	3	3	Known cause/Uncertainty in corrective action. Some residual risk.
		4	Unknown cause/Uncertainty in corrective action. Some residual risk.

Red Flag Problem/Failure Reports
Project Manager Approval Required

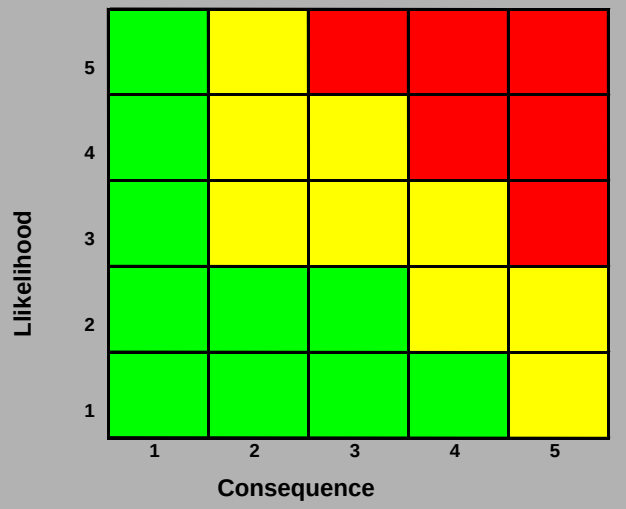
Waivers

Low

Medium

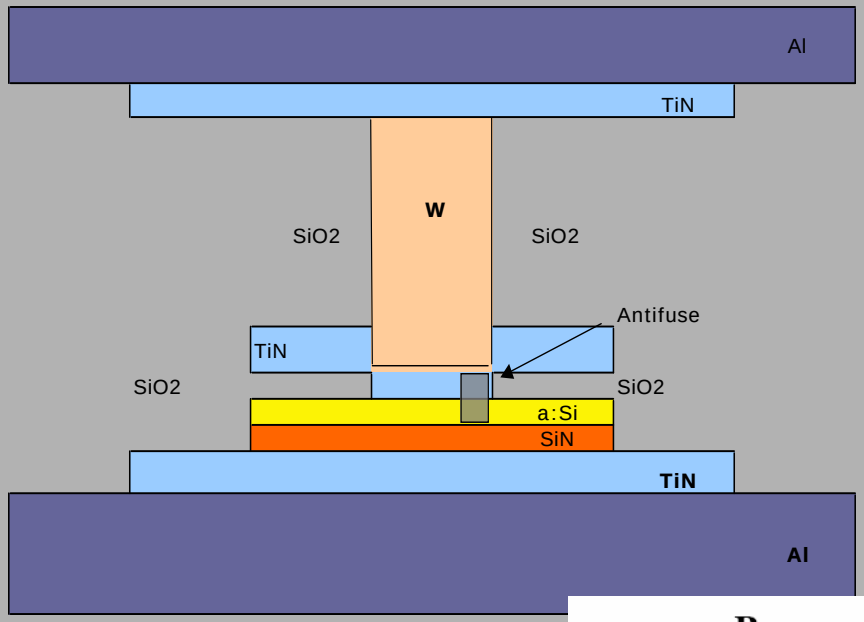
High

Formal Risk Management

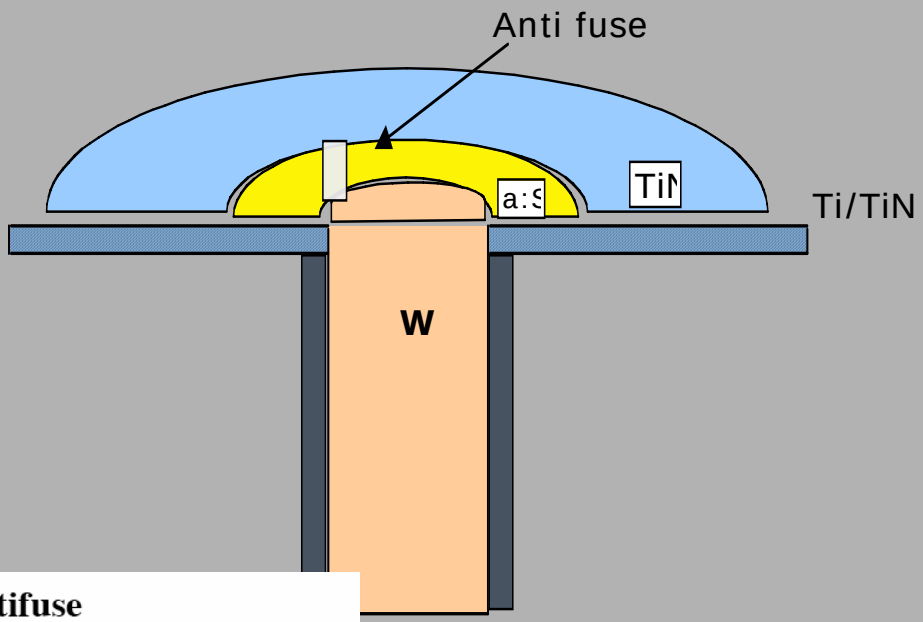


MRO FPGA Risk - Case Study

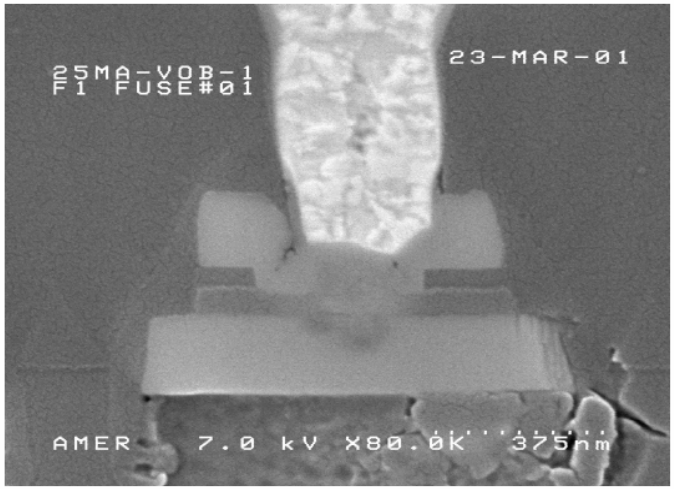
Baseline



New Foundry

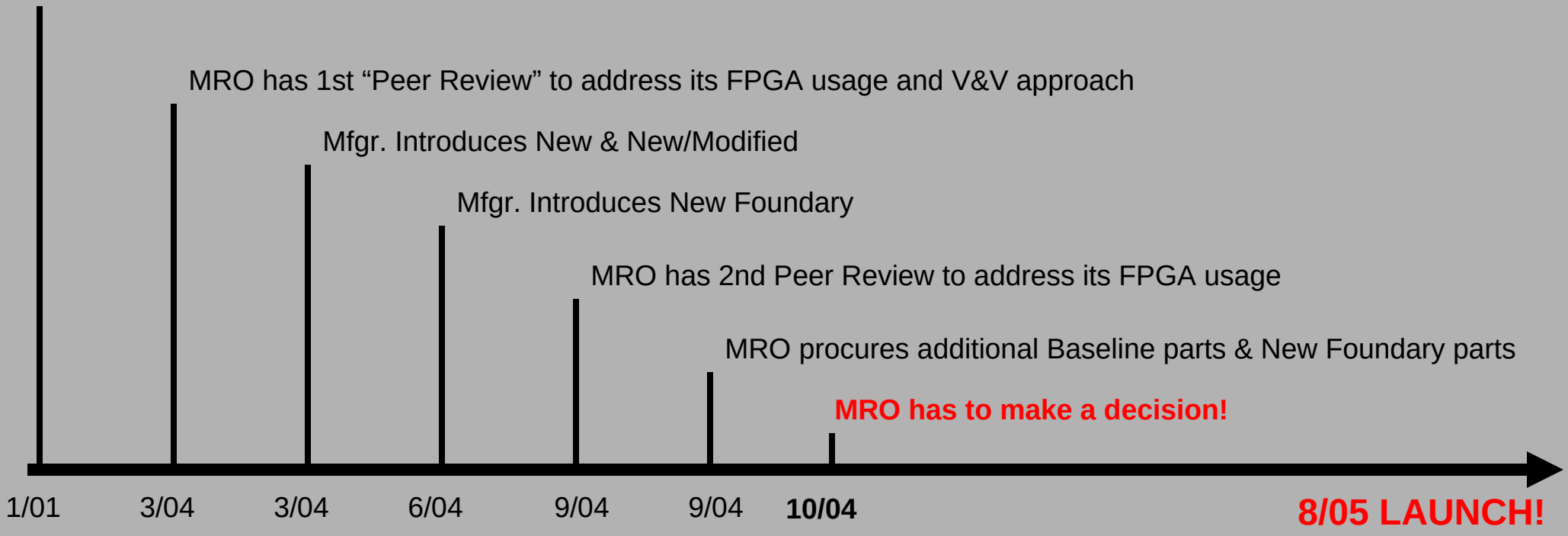


Programmed Antifuse



Decision Timeline

MRO determines that FPGA Post Programming Tri-Temperature Testing will be performed but not burn-in



100 FPGAs on MRO

-Across all subsystems & Instruments

-Almost all through box level qual

Key Risks Against Various FPGA Configurations

MRO Baseline

- Infant mortals or long term concerns
- Fall-out during ATLO
- How to accelerate defects
- Test design too stressful

New Algorithm

- Independent Verification
- Pin-hole defects exist
- How to accelerate defects
- Will testing stop on this algorithm due to new release
- Test design too stressful

What is a "High Risk" Design or Application?

New/Modified Algorithm

?

New Foundry

- Tested to same standards as Baseline
- Drop in replacement
- Other problems
- Algorithm
- When available

Moral to the Story

- Risk Management decisions need expert technical judgment
- Mitigation plans [for critical risks] need to be very flexible with key decision points identified
  - You are dealing with the unknown…
  - Resources limit your mitigations
- Projects can't jump on the "band wagon" to solve their problems

What has worked for MRO:

- Office Managers “approving” risks in their areas and owning them
- Review boards “reasonably” pushing on the project to improve its risk management process
- Near 1 FTE dedicated support for RM
- Mitigation plans & strategies for all Red & Yellow risks
- Integrated risk lists with outside suppliers
- Peer Reviews!
- MRO was ready for the launch readiness reviews - constantly poking at project risks

What hasn't worked as well:

- Outside project personnel assisting/owning the process - no ownership
- Keeping OMs engaged and keeping their risks moving & updated (being as proactive as we should)
- Mixing Problems & Risk Management
- Management's desire to attach reserves to every item on the risk list

If I had it to start over…

- Start with one project master risk list
- More closely tie margins management to the risk process
- Have someone dedicated to the RM process from the beginning
- Forego the elaborate tools
- Sensitize project elements that putting items on the risk list is not a bad thing

Final Remarks

- Risk Management provided a structured means for MRO management and project elements to communicate about risks and mitigation strategies

- MRO received Risk Management action items from NASA IRT at PMSR and PDR. At CDR the MRO RM process was praised

- MRO was launched successfully and is meeting all of its operational objectives